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(54) Modular unit for converting punching machines from single-punch to multiple-punch

(57) A modular conversion unit for converting punching machines from single-punch to multiple-punch comprises an upper main cylindrical magazine (3) rotatably supported by a turret (1) of the punching machine and provided with a plurality of radial seats (4a-4e) for accommodating corresponding upper secondary cylindrical magazines (5a-5e), supporting a preset number of punches (6) surmounted by corresponding hammer elements (7a-7e) fitted so as to rotate, a corresponding lower main cylindrical die-holder magazine (8) accommodated so as to rotate synchronously and in alignment with said upper cylindrical magazine in a hollow seat (8a) formed in a worktable (2) of the punching machine and provided with a corresponding number of radial seats (9a-9e) for lower secondary die-holders (10a-10e) vertically aligned with the upper secondary magazines (5a-5e), each die-holder (10a-10e) being provided with a plurality of dies (11) whose number is equal to the number of the punches (6). The unit also comprises a first motor (12) for producing a controlled rotation of the upper main cylindrical magazine (3) with respect to the turret (1), a second motor (13) which intervenes alternatively and actuates, with a controlled rotation, the hammer elements (7a-7e) with respect to the corresponding secondary cylindrical magazines (5a-5e), and a third motor (14) for the controlled rotation of the lower main cylindrical magazine (8) with respect to the seat synchronously with the upper main magazine (3).

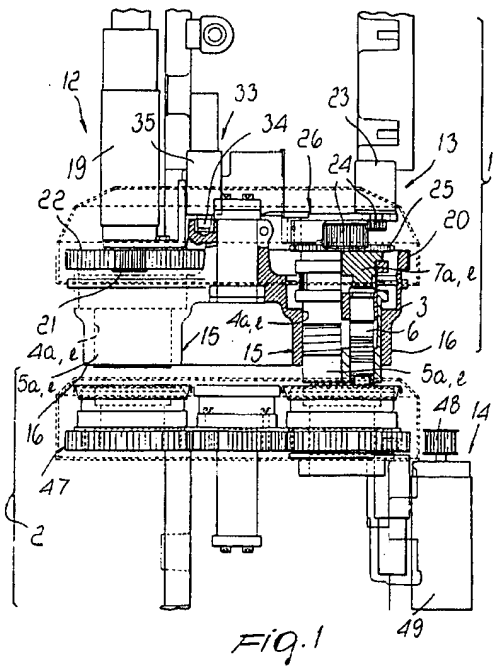

Fig. 1

EP 1 138 411 A2

Description

[0001] The present invention relates to a modular conversion unit for converting punching machines from single-punch to multiple-punch.

[0002] Conventional punching machines for machining metal plates comprise a footing provided with a worktable and an overlying turret which supports the hammer acting on the punches.

[0003] In turn, the worktable is provided with an oppositely arranged die adapted to receive the tip of the punch whenever it is actuated in order to perforate a metal plate.

[0004] These punching machines suffer a lot of drawbacks, including the fact that it is not possible to have a plurality of punches simultaneously available without having to replace them, in each instance, in the corresponding support in order to perform mutually different kinds of machining.

[0005] A second drawback of conventional punching machines is the limited space available between the surface for supporting the plates to be machined and the lower face of the punch holder, which is usually of a few centimeters.

[0006] Consequently, maintenance, generally required by jamming of the plates and punches or of the plates and the underlying dies, due to the machining waste produced by using said machines, is performed with great difficulty.

[0007] Finally, removal of the dies, which must be performed every time the punch is replaced with another one, also entails objective difficulties caused by the complexity of the maneuvers to be performed in order to extract the die from its seat: in conventional punching machines it is in fact necessary to disassemble a significant part of the working platform in order to be able to free the seat of the dies.

[0008] The aim of the present invention is to solve the above-mentioned problems of the prior art by providing a modular conversion unit for converting punching machines from single-punch to multiple-punch which allows to have available a wide range of punches ready for use without having to perform replacements and also allows, by way of its configuration, easier access for operators in the interspace between the turret and the worktable and for rapid replacement of the lower dies.

[0009] This aim and other objects, which will become more apparent hereinafter, are achieved by a modular conversion unit for converting punching machines from single-punch to multiple-punch, characterized in that it comprises an upper main cylindrical magazine which is rotatably supported by a turret of the punching machine and is provided with a plurality of radial seats for accommodating corresponding upper secondary cylindrical magazines, each of which supports a preset number of punches and is surmounted by a corresponding hammer element which is fitted so as to rotate in a controlled way, a corresponding lower main cylindrical die-holder magazine which is accommodated so as to rotate synchronously with said upper cylindrical magazine and is vertically aligned coaxially thereto in a hollow seat which is formed in a working platform of the punching machine and is provided with a corresponding number of radial seats for accommodating lower secondary die-holders supported so as to be vertically aligned with said upper secondary magazines, each die-holder being provided with a plurality of dies whose number is equal to the number of said punches, a first motor means being provided for producing a controlled rotation of said upper main cylindrical magazine with respect to said turret, a second motor means being also provided which intervenes alternatively and is meant to actuate, with a controlled rotation, said hammer elements with respect to the corresponding secondary cylindrical magazines, a third motor means being provided for the controlled rotation of said lower main cylindrical magazine with respect to said seat synchronously with said upper main magazine.

[0010] Further characteristics and advantages of the present invention will become apparent from the following detailed description of a preferred embodiment of a modular unit for converting punching machines from single-punch to multiple-punch, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a sectional side view of the modular unit according to the invention;
Figure 2 is a partially sectional detailed elevation view of a secondary cylindrical container of the modular unit according to the invention;
Figure 3 is a schematic plan view of an upper main cylindrical magazine, illustrating the seats for accommodating the secondary cylindrical magazines;
Figure 4 is another plan view, in phantom lines, of the upper main cylindrical magazine of Figure 3;
Figure 5 is a schematic detail view of a second alternative-intervention motor means for turning the hammer elements;
Figure 6 is a schematic plan view of a lower main cylindrical die-holder magazine;
Figure 7 is an enlarged-scale detail view of a die-holder accommodated in the corresponding seat.

[0011] With reference to the above figures, 1 and 2 respectively designate a punch-holder turret of a punching machine and a lower surface for supporting and machining metal plates, in which a die-holder is generally accommodated.

[0012] According to the invention, a modular conversion unit for converting the punching machine is mounted on a turret 1 and a worktable 2 and comprises an upper main cylindrical magazine 3, which is rotatably supported by the turret 1 and is provided with a series of radial seats, a total of five in the specific case, designated by 4a, 4b, 4c, 4d, 4e, which accommodate corre-

sponding upper secondary cylindrical magazines 5a, 5b, 5c, 5d, 5e, each of which supports a preset number of punches 6 and is surmounted by corresponding hammer elements 7a, 7b, 7c, 7d, 7e which are mounted so as to rotate in a controlled way.

[0013] A lower main cylindrical die-holder magazine 8 is correspondingly mounted flush in the worktable 2 and rotates synchronously with the upper one 3 and is vertically aligned coaxially thereto. The main cylindrical die-holder magazine 8 is inserted in a hollow seat 8a formed in the worktable 2 and is provided with a corresponding number, therefore five in the specific case, of further radial seats 9a, 9b, 9c, 9d, 9e for accommodating a corresponding number of lower secondary die-holders 10a, 10b, 10c, 10d, 10e which are supported so as to be vertically aligned with the upper secondary magazines 5a to 5e.

[0014] Each die-holder 10a to 10e is provided with a plurality of dies 11 whose total number corresponds to the number of the punches 6.

[0015] The modular unit 1 is provided with a first motor means 12 for the controlled rotary actuation of the upper main cylindrical magazine 3 with respect to the turret 1; with a second motor means 13, which intervenes alternatively for the controlled rotation of the hammer elements 7a to 7e with respect to the corresponding secondary cylindrical magazines 5a to 5e; and with a third motor means 14 for the controlled rotation of the lower main cylindrical magazine 8 with respect to its seat 8a and synchronously with the upper main magazine 3.

[0016] The radial seats 4a to 4e for accommodating the secondary cylindrical magazines 5a to 5e are mutually separated, in the lower region, by contoured gaps 15 which are formed correspondingly in the lower region of the main cylindrical magazine 3 and form corresponding lower protrusions 16 which are directed towards the worktable 2 of the punching machine.

[0017] The lower secondary die-holders 10a to 10e are supported by the corresponding lower main die-holder 8 with interposed slider means 17 which can be extracted in a radial direction and are kept in the position for use by means of corresponding locking elements 18.

[0018] The first motor means 12 is constituted by a corresponding first motor 19, which is supported by the turret 1, and by a perimetric set of teeth 20 which is associated with the main cylindrical magazine 3; the first motor 19 supports a corresponding first sprocket 21 which is keyed on its vertically protruding transmission shaft and rotates rigidly with it: a toothed belt 22 for connection and transmission is closed in a loop around said first sprocket 21 and said perimetric set of teeth 22.

[0019] The second alternative-intervention motor means 13, adapted to produce the controlled rotation of each hammer element 7a to 7e, is constituted by a corresponding second motor 23, also provided with a second sprocket 24 which is keyed on its vertically protruding transmission shaft and is adapted to engage corresponding second sets of teeth 25 formed perimetrically with respect to each hammer element.

[0020] The second motor 23 is supported by a supporting means 26 floating on a horizontal plane and is actuated between two positions which are proximal and distal with respect to each hammer element 7a to 7e with a feeler element 27 which is kept in constant contact, through corresponding elastic means which are not shown because they are of a conventional type, with a track 28 formed perimetrically on the upper main cylindrical magazine 3; the track 28 is provided, along its circumference, with a plurality of recesses 29 arranged substantially radially at each one of the seats 4a to 4e that accommodate the upper secondary cylindrical magazines 5a to 5e.

[0021] The floating supporting means 26 is constituted by a flange 30 which is supported horizontally and so as to rotate, at one edge, about a vertical axis 31 which is rigidly coupled to the structure that supports the turret 1 of the punching machine and to which the second motor 23 is rigidly coupled.

[0022] The feeler element 27 is constituted by at least one roller 32 which is mounted, so as to rotate freely, on the flange 30 with an axis which is perpendicular thereto and so that the contact and rolling surface faces the track 28; the recesses formed therein are blended with the rolling surface of the track 28 with ramps which have a rounded profile.

[0023] Means 33 for locking the rotation in predefined angular configurations which correspond to the positions for mutual engagement of the feeler element 27 and the recesses 29 are interposed between the turret 1 and the upper main cylindrical magazine 3.

[0024] The rotary locking means 33 are constituted by at least one pivot 34 which is supported vertically by the turret 1 with an interposed actuator 35 adapted to move it vertically in a reciprocating fashion between two positions, respectively a raised return position and a lowered position for engagement with corresponding gauged holes 36 formed along a circumferential generatrix, whose outline is designated by 37, on the upper face of the upper main cylindrical magazine 3 and is rotationally determined by the axial projection of the pivot 34 on the upper face.

[0025] The hammer elements 7a to 7e are each constituted by a cylindrical body 38 which is rotationally supported concentrically at the end of each upper secondary cylindrical magazine 5a to 5e with interposed elastic return means 39 for extracting the punch 6 and is provided, on its lower face, with a percussion tooth 40 which protrudes for alternating action on a selected punch 6.

[0026] The elastic return means 39 are constituted by a plurality of reactive compression springs 41 (see Figure 2) which are interposed between the bodies 38 and the upper secondary cylindrical magazines 5a to 5e.

[0027] The slider means 17 are constituted, for each lower secondary die-holder 10a to 10e, by a flat plate 42 which is provided with a hollow cylindrical seat 43 and is insertable by sliding and so as to be guided bilat-

erally in a corresponding receptacle formed in the main die-holder 8.

[0028] Each hollow seat 43 is vertically aligned, in the active configuration, above an underlying opening 44 formed in the worktable 2 of the punching machine.

[0029] The locking elements 18 are constituted, for each plate 42, by a contoured prism-shaped body 45 which can be arranged in contact with the outer side of each one of the plates and can be clamped in contact with the outer side by way of screw means 46.

[0030] Finally, the third motor means 14 for controlled rotation comprises a perimetric set of teeth 47 which is formed in the lower main cylindrical magazine 8 and can be coupled to a corresponding transmission sprocket 48 which is keyed on the vertical shaft of a third motor 49 which is rigidly associated with the structure of the worktable 2 of the punching machine.

[0031] The operation of the invention is as follows: a plurality of punches 6 is accommodated in the upper secondary magazines 5a to 5e in a conventional way, and in the same way a corresponding plurality of dies 11 is prepared inside the die-holders 10a to 10e.

[0032] The secondary magazines are then placed in the respective seats 4a to 4e and the die-holders are accommodated in the plates 42, which are in turn slidingly inserted in a centripetal direction in the respective seats 9a to 9e formed in radial directions in the main cylindrical magazine 8; once insertion has been completed, the die-holders 10a to 10e are vertically aligned with the corresponding secondary cylindrical magazines 5a to 5e and, therefore, with the respective punches 6.

[0033] The plates 42 are locked in position by clamping the prism-shaped bodies 45 against their corresponding outer sides.

[0034] The operator then places a sheet of metal plate to be punched on the worktable 2, between the worktable and the overlying turret 1, and chooses the punch 6 to be used among the available punches.

[0035] This choice determines the simultaneous and synchronous rotation, activated and controlled by the electronic circuits of the punching machine, of the main cylindrical magazine 3 and of the lower one 8 in order to move onto the punching point, in an upward region, the secondary magazine that supports the selected punch and, in a downward region, the corresponding die-holder.

[0036] The synchronous rotation is activated by the first motor 19 and by the third motor 49; the motor 19 acts on the set of teeth 22 of the upper cylindrical magazine 3 with the sprocket 21 interposed, and the third motor acts in a similar way on the set of teeth 47 with the sprocket 48 interposed.

[0037] During the positioning rotation, the roller 32 of the feeler element 27 rolls on the track 28, keeping the flange 30 and, with said flange, the second motor 23 spaced from the hammer elements 7a to 7e.

[0038] When the roller 32 enters the chosen recess 29, i.e. the recess located at the secondary container that accommodates the punch 6 to be used, the flange 30 rotates about the axis 31 and moves towards said selected container.

[0039] This approach moves the second sprocket 24 so as to engage the set of teeth 25, and the activation of the second motor 23 causes the cylindrical body 38 to rotate until the percussion tooth 40 aligns itself vertically above the punch 6 to be used.

[0040] The punching machine then performs the operation, and the extraction of the punch 6 from the metal plate is facilitated by the springs 41.

[0041] In order to change the punch 6 with another one, the operator again turns the upper main cylindrical magazine 3 and the lower one 8 until the new selection is reached, and punching occurs, as described earlier, without having to perform long and troublesome replacement operations, since the range of punches 6 ready for use is quite wide.

[0042] It should also be noted that the die-holders 10a to 10e can be easily extracted, for example in order to perform maintenance or urgent interventions caused by any jamming of the punching machine due to accidental interlocking of the metal plate and the punches: the extraction of said die-holders occurs by loosening the screw means 46 and by removing the body 45: by then pulling the handle 50, said die-holder is extracted; this operation is possible even when the metal plate is in position for punching.

[0043] After extraction, the useful gap that is formed between the turret 1 and the worktable 2 increases considerably; the gap is the sum of the free space produced between the hollow seat 43 and the shaped recesses 15 formed in the upper main cylindrical magazine 3.

[0044] This space allows operators to easily access the region where the accidental interlockings occur, rapidly restoring the functionality of the punching machine, or performing the ordinary periodic maintenance operations.

[0045] In practice it has been observed that the above-described invention achieves the intended aim, i.e. it allows to have a large number of punches ready for use in a conventional punching machine without resorting to disassembly and reassembly for their replacement, and to have suitable space for interventions to be performed between the turret and the worktable.

[0046] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0047] All the details may further be replaced with other technically equivalent ones.

[0048] In practice, the materials employed, as well as the shapes and the dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

[0049] The disclosures in UK Patent Application No. 0007799.0 from which this application claims priority are incorporated herein by reference.

[0050] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A modular conversion unit for converting punching machines from single-punch to multiple-punch, **characterized in that** it comprises an upper main cylindrical magazine (3) which is rotatably supported by a turret (1) of the punching machine and is provided with a plurality of radial seats (4a÷4e) for accommodating corresponding upper secondary cylindrical magazines (5a÷5e), each of which supports a preset number of punches (6) and is surmounted by a corresponding hammer element (7a÷7e) which is fitted so as to rotate in a controlled way, a corresponding lower main cylindrical die-holder magazine (8) which is accommodated so as to rotate synchronously with said upper cylindrical magazine (3) and is vertically aligned coaxially thereto in a hollow seat (8a) which is formed in a worktable (2) of the punching machine and is provided with a corresponding number of radial seats (9a÷9e) for accommodating lower secondary die-holders (10a÷10e) which are supported so as to be vertically aligned with said upper secondary magazines (5a÷5e), each die-holder (10a÷10e) being provided with a plurality of dies (11) the number whereof is equal to the number of said punches (6), a first motor means (12) being provided for producing a controlled rotation of said upper main cylindrical magazine (3) with respect to said turret (1), a second motor means (13) being also provided which intervenes alternatively to actuate, with a controlled rotation, said hammer elements (7a÷7e) with respect to the corresponding secondary cylindrical magazines (5a÷5e), a third motor means (14) being provided for a controlled rotation of said lower main cylindrical magazine (8) with respect to said seat (8a) synchronously with said upper main magazine (3).

2. The modular conversion unit according to claim 1, **characterized in that** said radial seats (4a÷4e) for accommodating said secondary cylindrical magazines (5a÷5e) are mutually separated in the lower region by contoured gaps (15) which are formed correspondingly in the lower region of said main cylindrical magazine (3) and form corresponding lower protrusions (16) which are directed towards said worktable (2) of the punching machine.

3. The modular conversion unit according to claim 1, **characterized in that** said lower secondary die-holders (10a÷10e) are supported by the corresponding lower main die-holder (8) with interposed slider means (17) with radial extraction which are kept in the working position by corresponding locking elements (18).

4. The modular conversion unit according to claim 1, **characterized in that** said first motor means (12) is constituted by a corresponding first motor (19) which is supported by said turret (1) and by a perimetric set of teeth (20) which is associated with said main cylindrical magazine (3), said first motor (19) having a corresponding first sprocket (21) which is keyed and rigidly rotationally coupled on the vertically protruding transmission shaft of said motor (19), a toothed belt (22) for transmission and connection being closed in a loop around said first sprocket (21) and said perimetric set of teeth (22).

5. The modular conversion unit according to claim 1, **characterized in that** said second alternative-intervention motor means (13) for the controlled rotary actuation of each hammer element (7a÷7e) is constituted by a corresponding second motor (23) which has a second sprocket (24) keyed onto the vertically protruding transmission shaft for engagement with corresponding second sets of teeth (25) formed perimetrically with respect to each hammer element (7a÷7e).

6. The modular conversion unit according to claim 5, **characterized in that** said second motor (23) is supported by a supporting means (26) which floats on a horizontal plane and is actuated between two positions, a proximal one and a distal one, with respect to each hammer element (7a÷7e), with a feeler element (27) which is kept in constant contact, by way of corresponding elastic means, with a track (28) formed perimetrically on said upper main cylindrical magazine (3), said track (28) being provided, along its circumference, with a plurality of recesses (29) located substantially radially at each one of said radial seats (4a÷4e) for said upper secondary cylindrical magazines (5a÷5e).

7. The modular conversion unit according to claim 6, **characterized in that** in each configuration for the engagement of said feeler element (27) in said recesses (29) said sprocket (24) correspondingly engages, so as to rotationally actuate it, a corresponding second set of teeth (25) of a hammer element (7a÷7e), or, in the opposite configuration for the disengagement of said feeler element (27), said sprocket (24) is disengaged from each second set of teeth (25).

8. The modular conversion unit according to claim 6, **characterized in that** said floating supporting means (26) is constituted by a flange (30) which is supported horizontally and can rotate, at one edge, about a vertical axis which is rigidly coupled to the supporting structure of said turret (1) of the punching machine and to which said second motor (23) is rigidly coupled.

9. The modular conversion unit according to claim 7, **characterized in that** said feeler element (27) is constituted by at least one roller (32) which is mounted so as to rotate freely on said flange (30) with an axis which is perpendicular thereto and so that the contact and rolling surface is directed towards said track (28).

10. The modular conversion unit according to claim 6, **characterized in that** said recesses (29) are blended with the rolling surface of said track (28) with ramps which have a rounded profile.

11. The modular conversion unit according to claim 6, **characterized in that** between said turret (1) and said upper main cylindrical magazine (3) means (33) are interposed for locking the rotation in predefined angular configurations which correspond to said configurations for engagement between said feeler element (27) and said recesses (29).

12. The modular conversion unit according to claim 11, **characterized in that** said rotary locking means (33) are constituted by at least one pivot (34) which is supported vertically by said turret (1) with an interposed actuator (35) for alternative vertical movement between two positions, a raised return position and a lowered engagement position, and by corresponding gauged holes (36) which are formed on a circumferential generatrix of the upper face of said upper main cylindrical magazine (3) which is rotationally determined by the axial projection of said pivot (34) onto said upper face.

13. The modular conversion unit according to claim 1, **characterized in that** said hammer elements (7a÷7e) are each constituted by a cylindrical body (38) which is rotationally supported concentrically at the end of each upper secondary cylindrical magazine (5a÷5e) with interposed elastic return means (39) and is provided, on its lower face, with a percussion tooth (40) which protrudes for alternating action on a selected punch (6).

14. The modular conversion unit according to claim 13, **characterized in that** said elastic return means (39) are constituted by a plurality of reactive compression springs (41) which are interposed between said hammer elements (7a÷7e) and said upper secondary cylindrical magazines (5a÷5e).

15. The modular conversion unit according to claim 3, **characterized in that** said slider means (17) are constituted, for each lower secondary die-holder (10a÷10e), by a flat plate (42) which is provided with a hollow cylindrical seat (43) which can be slidingly inserted, so as to be guided on both sides, in a corresponding receptacle formed in said main die-holder (8).

16. The modular conversion unit according to claim 15, **characterized in that** each hollow seat (43) is vertically aligned, in an active configuration, on an underlying opening (44) which is formed in said worktable (2) of the punching machine.

17. The modular conversion unit according to claim 15, **characterized in that** said locking elements (18) are constituted, for each plate (42), by a prism-shaped contoured body (45) which can be arranged in contact with the outer side of each one of said plates, said body (45) being lockable in contact with said outer side by way of screw means (46).

18. The modular conversion unit according to claim 1, **characterized in that** said third motor means (14) for controlled rotation comprises a perimetric set of teeth (47) which is formed in said lower main cylindrical magazine (8) and can be coupled to a corresponding transmission sprocket (48) which is keyed onto the vertical shaft of a third motor (49) which is rigidly associated with said worktable (2) of the punching machine.

19. The modular conversion unit according to claim 1, **characterized in that** said first (19) and third (49) motors can be actuated so as to rotate synchronously in angular steps which can be counted through corresponding means adapted to keep said punches (6) vertically aligned with said dies (11).

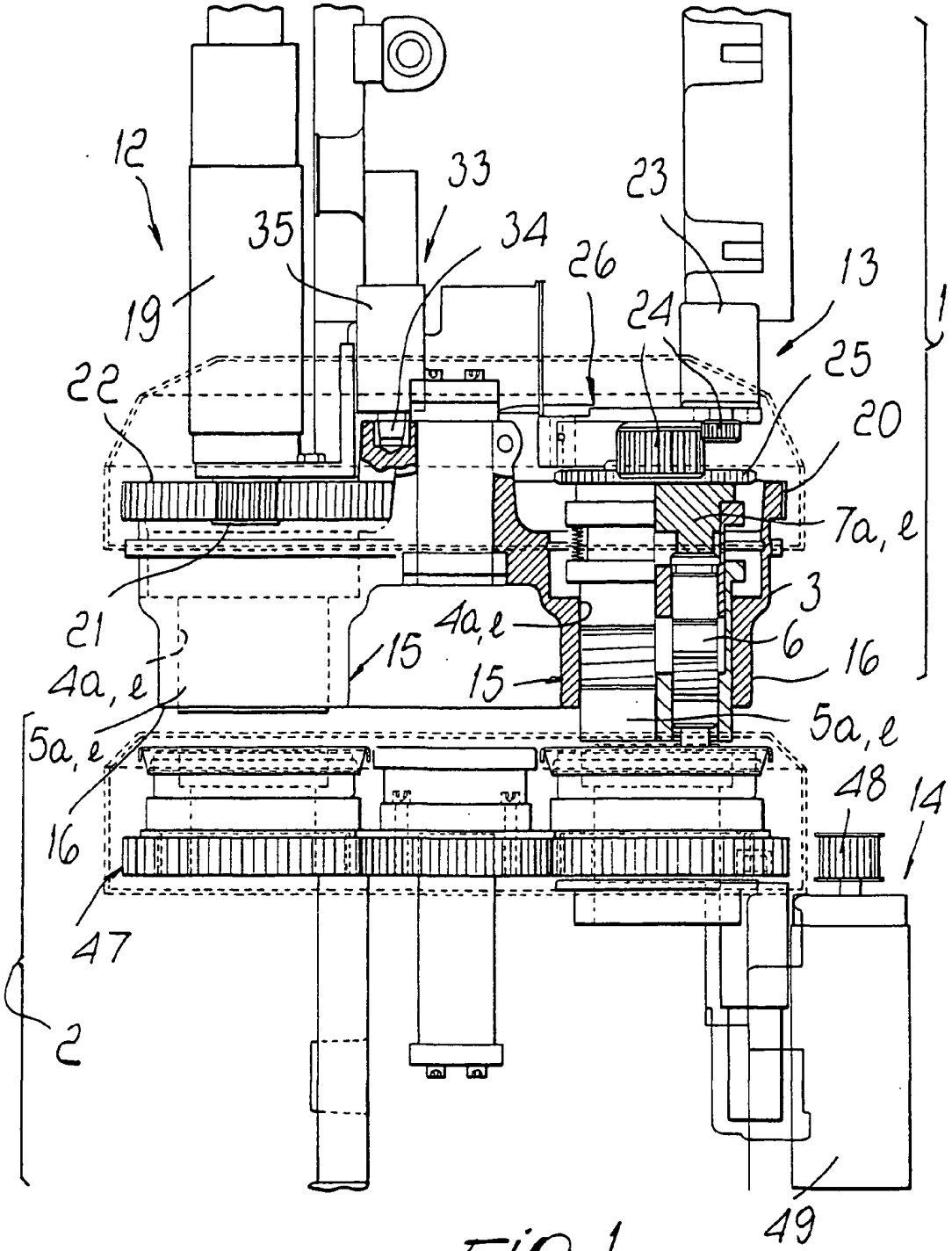
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Fig. 1

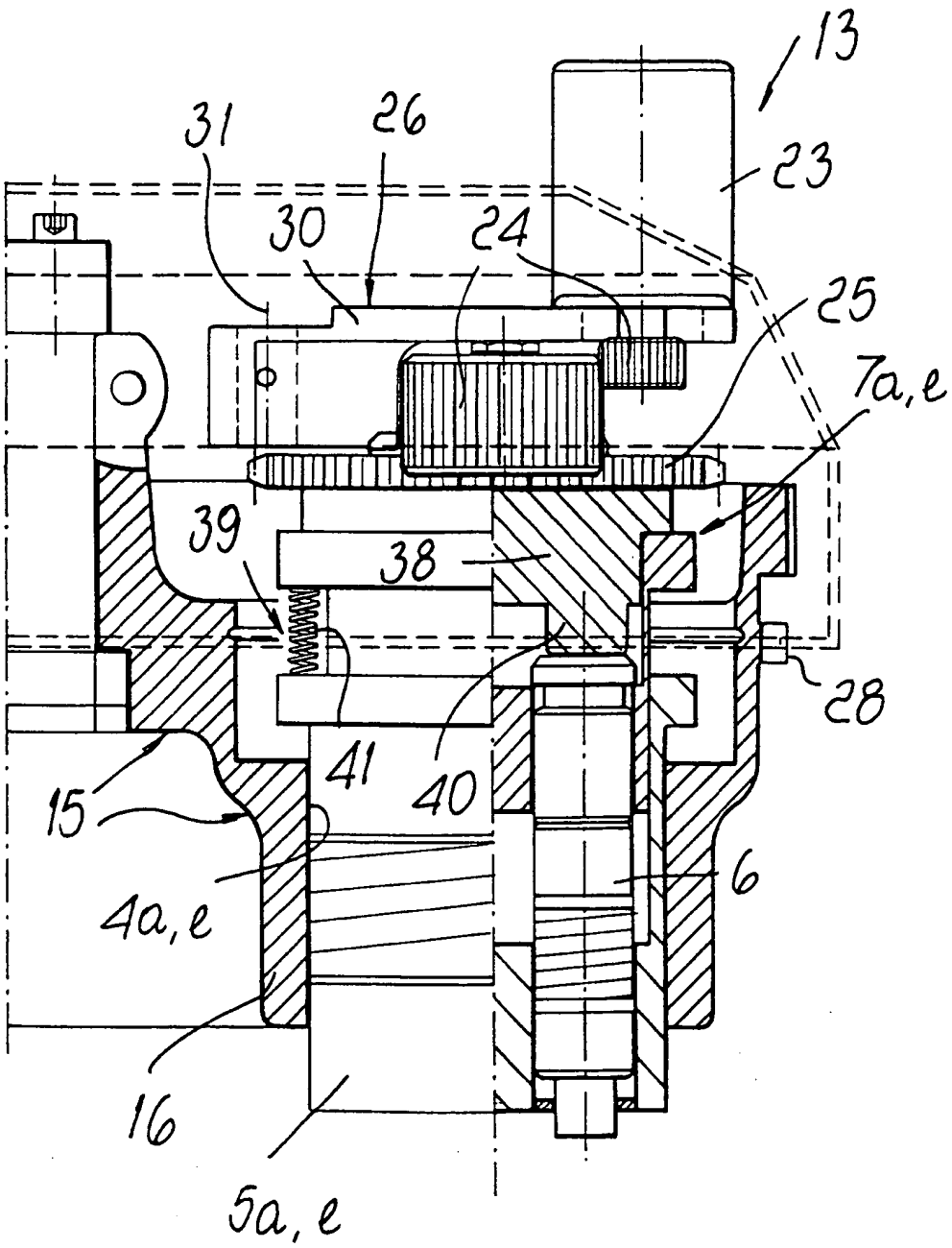

Fig. 2

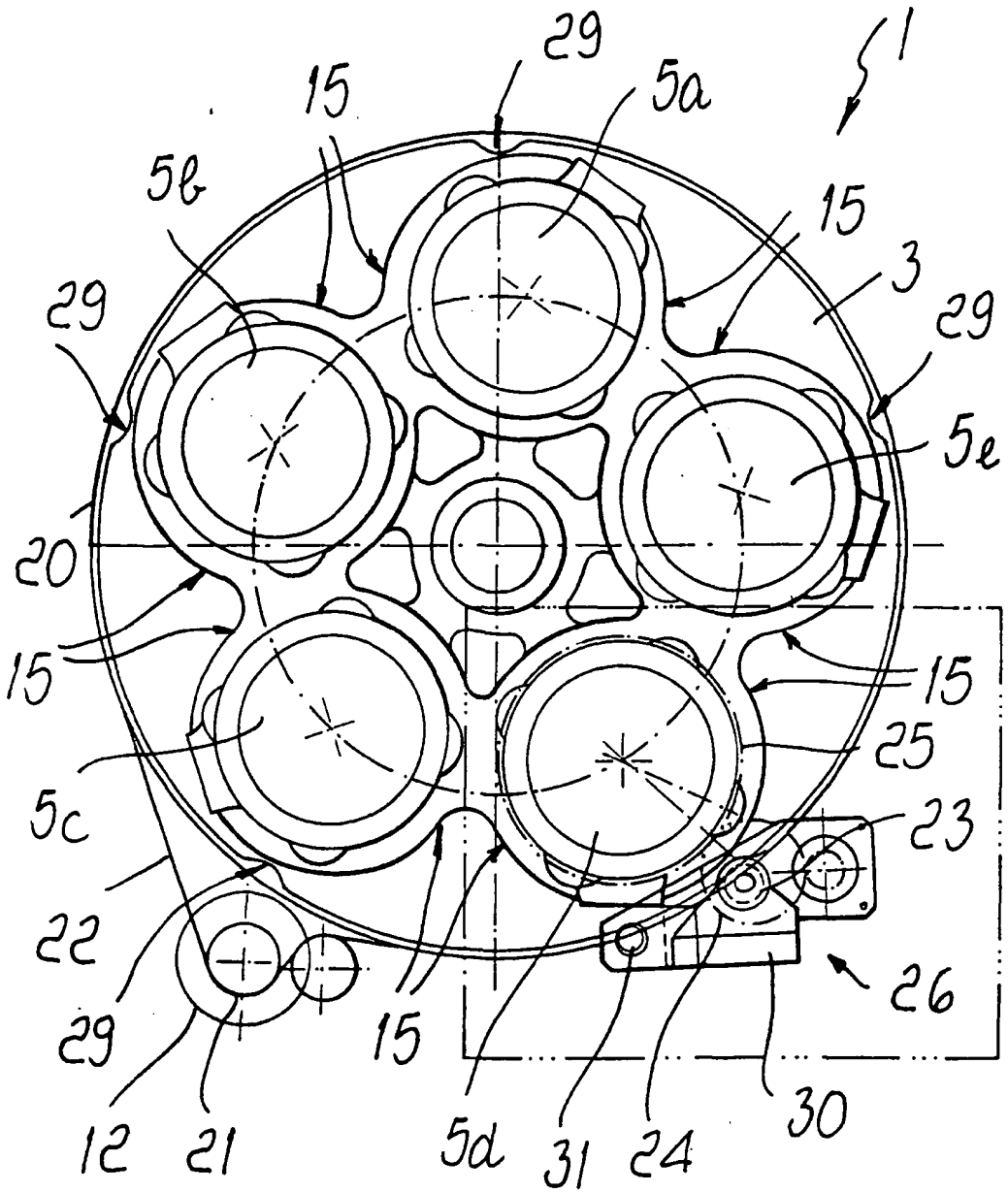
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Fig. 3

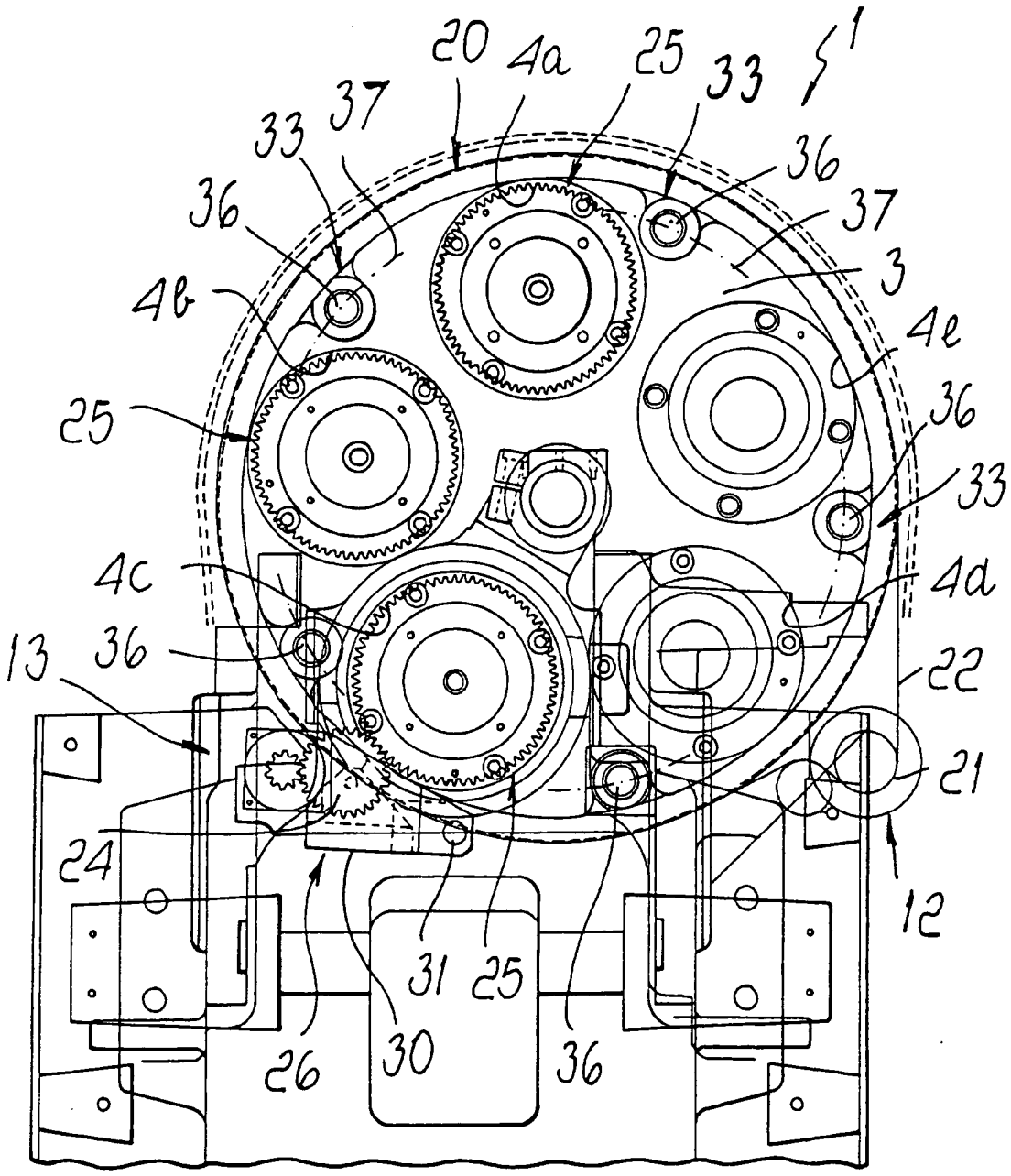
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Fig. 4

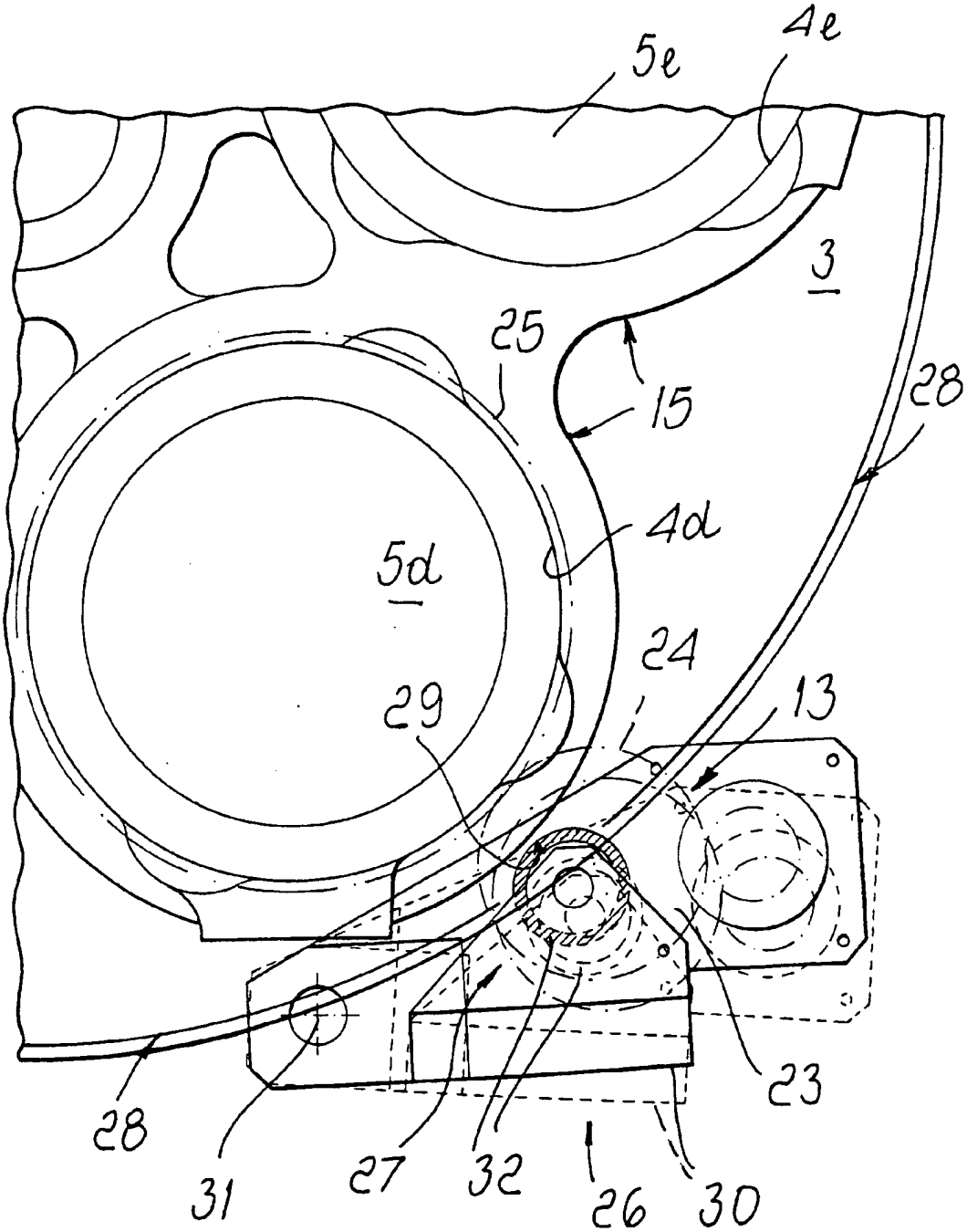

Fig. 5

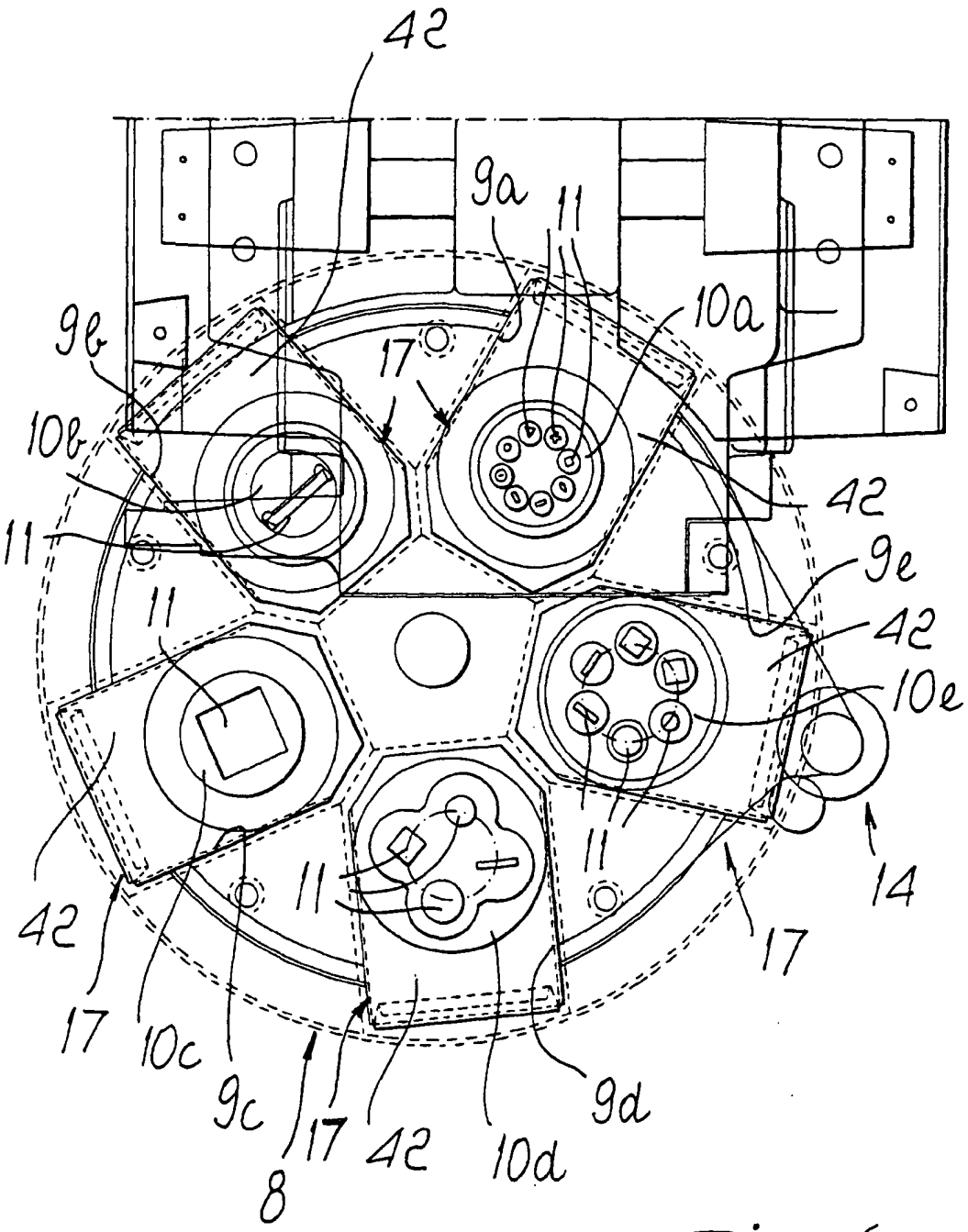
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Fig. 6

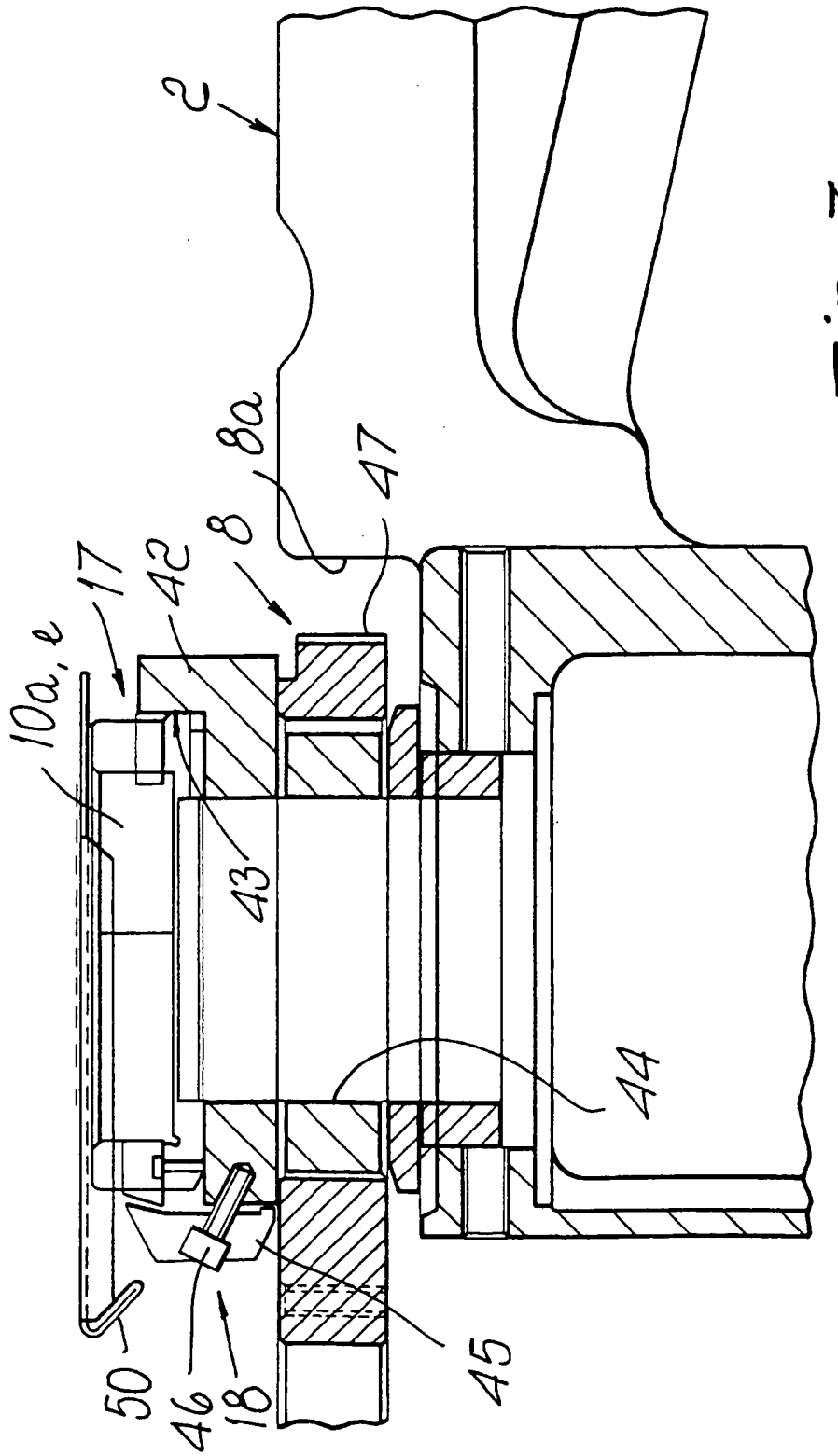

Fig. 7